

Appl. No. 09/782,892

Amendments to the Claims:

Please cancel claims 14, 31 and 53, amend claims 1, 15, 16, 17, 22, 32, 33, 46 and 54, and add new claims 223-276 as follows:

Listing of Claims:

1. (Currently Amended) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium; [[and]]

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston

Appl. No. 09/782,892

and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder.

2. (Original) The apparatus of claim 1 wherein the planarizing medium includes a polishing pad.

3. (Original) The apparatus of claim 1 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

4. (Original) The apparatus of claim 1 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

5-6. (Canceled)

7. (Original) The apparatus of claim 1 wherein the sensor includes a force sensor.

8-9. (Canceled)

10. (Original) The apparatus of claim 1, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

11-14. (Canceled)

15. (Currently Amended) The apparatus of claim [[14]] 1 wherein the piston is sealably engaged with the cylinder.

Appl. No. 09/782,892

16. (Currently Amended) The apparatus of claim [[14]] 1, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

17. (Currently Amended) The apparatus of claim [[14]] 1 wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

18-21. (Canceled)

22. (Currently Amended) An apparatus for measuring forces during conditioning of a chemical-mechanical planarizing surface, comprising:

a planarizing medium having a planarizing surface for removing material from a microelectronic substrate, the planarizing surface defining a planarizing surface plane;

a conditioning body adjacent to the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium for conditioning the planarizing surface, the conditioning body and the planarizing medium generating a force in the planarizing surface plane when the one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium;

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force; [[and]]

a sensor operatively coupled to the conditioning body to detect the force;

a piston; and

Appl. No. 09/782,892

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the force sensor including a gauge positioned to measure movement of the piston relative to the cylinder.

23. (Original) The apparatus of claim 22 wherein the planarizing medium includes a polishing pad.

24. (Original) The apparatus of claim 22 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

25. (Original) The apparatus of claim 22 wherein the conditioning body is rotatable relative to the planarizing medium.

26. (Original) The apparatus of claim 22 wherein the conditioning body is translatable relative to the planarizing medium.

27. (Original) The apparatus of claim 22 wherein the planarizing medium is rotatable relative to the conditioning body.

28. (Canceled)

29. (Original) The apparatus of claim 22 wherein the sensor includes a force sensor.

30-31. (Canceled)

32. (Currently Amended) The apparatus of claim [[31]] 22 wherein the piston is sealably engaged with the cylinder.

Appl. No. 09/782,892

33. (Currently Amended) The apparatus of claim ~~[[31]]~~ 22, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

34. (Original) The apparatus of claim 22, further comprising a feedback device coupled to the sensor and the conditioning body for changing at least one of the force between the conditioning body and the polishing pad and a position of the conditioning body relative to the polishing pad in response to a signal from the sensor.

35. (Previously Presented) An apparatus for monitoring conditioning of a planarizing medium used for chemical-mechanical planarization of a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface, the conditioning body generating a drag force generally parallel to the planarizing surface;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor being positioned to detect relative motion between the piston and the cylinder;

an actuator coupled to the conditioning body with a support assembly to control at least one of a generally normal force between the conditioning body and the planarizing medium and a position of the conditioning body relative to the planarizing medium;

a sensor coupled to the support assembly to detect the drag force; and

a feedback device coupled to the actuator to control activation of the actuator in response to a signal received from the force sensor.

Appl. No. 09/782,892

36. (Original) The apparatus of claim 35 wherein the feedback device includes a microprocessor.

37. (Original) The apparatus of claim 35 wherein the actuator is positioned to move the conditioning body laterally over the planarizing surface.

38. (Original) The apparatus of claim 35 wherein the actuator is positioned to rotate the conditioning body in a generally circular motion over the planarizing surface.

39. (Original) The apparatus of claim 35 wherein the planarizing medium includes a polishing pad.

40. (Original) The apparatus of claim 35, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force.

41. (Original) The apparatus of claim 35 wherein the sensor includes a force sensor.

42-43. (Canceled)

44. (Previously Presented) The apparatus of claim 35 wherein the piston is sealably engaged with the cylinder and the sensor includes a pressure gauge positioned within the gap to detect a change in pressure in the gap when one of the piston and the cylinder moves relative to the other.

Appl. No. 09/782,892

45. (Previously Presented) The apparatus of claim 35, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

46. (Currently Amended) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

moving at least one of the planarizing medium and a conditioning body relative to the other of the planarizing medium and the conditioning body while the conditioning body is engaged with a planarizing surface of the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, the support member including a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein the support member includes a piston slidably received in a cylinder; [[and]]

monitoring the conditioning body to detect a force of the planarizing medium on the conditioning body, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder ~~a force between the upwardly extending portion and the laterally extending portion with a force sensor.~~

47. (Original) The method of claim 46 wherein monitoring the conditioning body includes detecting a frictional force on the conditioning body in a plane generally parallel to a plane of the planarizing surface.

48-53. (Canceled)

54. (Currently Amended) The method of claim ~~[[53]]~~ 46, further comprising biasing one of the piston and the cylinder toward or away from the other of the piston and the cylinder.

Appl. No. 09/782,892

55. (Previously Presented) The method of claim 46 wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston, further wherein monitoring the conditioning body includes detecting a pressure within the sealed space.

56. (Canceled)

57. (Original) The method of claim 46, further comprising removing material from the planarizing medium while at least one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium.

58. (Original) The method of claim 46, further comprising adjusting a force applied to the conditioning body approximately normal to the planarizing surface in response to detecting a force of the planarizing medium on the conditioning body.

59. (Original) The method of claim 46 wherein moving at least one of the planarizing medium and the conditioning body includes rotating the planarizing medium at a variable rate as the conditioning body moves across the planarizing medium to maintain a relative velocity between the planarizing medium and the conditioning body at an approximately constant value.

60. (Previously Presented) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, the method comprising:

coupling a sensor to a conditioning body, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, and the support member includes a piston slidably received in a cylinder;

engaging the conditioning body with the planarizing medium and moving at least one of the conditioning body and the planarizing medium relative to the other of the conditioning body and the planarizing medium while the conditioning body engages the planarizing medium; and

Appl. No. 09/782,892

monitoring the conditioning body to detect a frictional force between the conditioning body and the planarizing medium, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

61-64. (Canceled)

65. (Previously Presented) The method of claim 60 wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston, further wherein monitoring the conditioning body includes detecting a pressure within the sealed space.

66-77. (Canceled)

78. (Previously Presented) A method for conditioning a planarizing medium used for planarizing a semiconductor substrate, the method comprising:

engaging a conditioning body with the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, and further wherein the support member includes a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion;

moving at least one of the conditioning body and the planarizing medium relative to the other of the conditioning body and the planarizing medium to remove material from the planarizing medium; and

maintaining an approximately constant frictional force between the conditioning body and the planarizing medium by adjusting a relative velocity between the conditioning body and the planarizing medium, wherein maintaining an approximately constant frictional force includes selecting a target frictional force, detecting a force between the upwardly extending portion and the laterally extending portion coupled to the conditioning body, and adjusting the relative velocity until the force is approximately equal to the target frictional force, and further

Appl. No. 09/782,892

wherein measuring a force transmitted to the support member includes detecting a force between the upwardly extending portion and the laterally extending portion with a force sensor.

79-81. (Canceled)

82. (Previously Presented) The method of claim 78 wherein the support member includes a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein detecting the force includes detecting a force between the upwardly extending portion and the laterally extending portion with a force sensor.

83. (Canceled)

84. (Previously Presented) The method of claim 78 wherein the support member includes a piston slidably received in a cylinder and detecting the force includes detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

85. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston; and

a cylinder having an open end and a closed end, the cylinder sealably and slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning

Appl. No. 09/782,892

body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a sealed gap between an end of the piston and the closed end of the cylinder, the sensor being positioned within the gap for measuring a change in pressure within the gap as the piston moves relative to the cylinder.

86. (Original) The apparatus of claim 85 wherein the planarizing medium includes a polishing pad.

87. (Original) The apparatus of claim 85 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

88. (Original) The apparatus of claim 85 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

89. (Original) The apparatus of claim 85, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

90. (Original) The apparatus of claim 85 wherein the sensor includes a force sensor.

91. (Original) The apparatus of claim 85, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing

Appl. No. 09/782,892

medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

92. (Original) The apparatus of claim 85 wherein the piston has a generally circular cross-sectional shape and the cylinder has an aperture with a generally circular cross-sectional shape for receiving the piston.

93. (Original) The apparatus of claim 85 wherein the piston has a generally rectangular cross-sectional shape and the cylinder has an aperture with a generally rectangular cross-sectional shape for receiving the piston.

94. (Original) The apparatus of claim 85 wherein the piston is sealably engaged with the cylinder.

95. (Original) The apparatus of claim 85, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

96. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston; and

a cylinder having an open end and a closed end, the cylinder sealably and slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning

Appl. No. 09/782,892

body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, wherein the piston has a generally circular cross-sectional shape and the cylinder has an aperture with a generally circular cross-sectional shape for receiving the piston, and further wherein the piston and the cylinder define a sealed gap between an end of the piston and the closed end of the cylinder, the sensor being positioned within the gap for measuring a change in pressure within the gap as the piston moves relative to the cylinder.

97. (Original) The apparatus of claim 96 wherein the planarizing medium includes a polishing pad.

98. (Original) The apparatus of claim 96 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

99. (Original) The apparatus of claim 96 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

100. (Original) The apparatus of claim 96, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and
a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

101. (Original) The apparatus of claim 96 wherein the sensor includes a force sensor.

102. (Original) The apparatus of claim 96, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning

Appl. No. 09/782,892

body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

103. (Original) The apparatus of claim 96 wherein the piston is sealably engaged with the cylinder.

104. (Original) The apparatus of claim 96, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

105. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston; and

a cylinder having an open end and a closed end, the cylinder sealably and slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a sealed gap between an end of the piston and the closed end of the cylinder, wherein the piston has a generally rectangular cross-sectional shape and the cylinder has an aperture with a generally rectangular cross-sectional shape for receiving the piston, and further wherein the sensor being positioned within the gap for measuring a change in pressure within the gap as the piston moves relative to the cylinder.

Appl No. 09/782,892

106. (Original) The apparatus of claim 105 wherein the planarizing medium includes a polishing pad.

107. (Original) The apparatus of claim 105 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

108. (Original) The apparatus of claim 105 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

109. (Original) The apparatus of claim 105, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

110. (Original) The apparatus of claim 105 wherein the sensor includes a force sensor.

111. (Original) The apparatus of claim 105, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

112. (Original) The apparatus of claim 105 wherein the piston is sealably engaged with the cylinder.

Appl. No. 09/782,892

113. (Original) The apparatus of claim 105, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

114. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder.

115. (Original) The apparatus of claim 114 wherein the planarizing medium includes a polishing pad.

116. (Original) The apparatus of claim 114 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

117. (Original) The apparatus of claim 114 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

Appl. No. 09/782,892

118. (Original) The apparatus of claim 114, further comprising:

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

119. (Original) The apparatus of claim 114 wherein the sensor includes a force sensor.

120. (Original) The apparatus of claim 114, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

121. (Original) The apparatus of claim 114 wherein the piston is sealably engaged with the cylinder.

122. (Original) The apparatus of claim 114, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

123. (Original) The apparatus of claim 114 wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

Appl. No. 09/782,892

124. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, wherein the piston is sealably engaged with the cylinder and further wherein the sensor includes a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder.

125. (Original) The apparatus of claim 124 wherein the planarizing medium includes a polishing pad.

126. (Original) The apparatus of claim 124 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

127. (Original) The apparatus of claim 124 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

Appl. No. 09/782,892

128. (Original) The apparatus of claim 124, further comprising:

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

129. (Original) The apparatus of claim 124 wherein the sensor includes a force sensor.

130. (Original) The apparatus of claim 124, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

131. (Original) The apparatus of claim 124 wherein the piston has a generally circular cross-sectional shape and the cylinder has an aperture with a generally circular cross-sectional shape for receiving the piston.

132. (Original) The apparatus of claim 124 wherein the piston has a generally rectangular cross-sectional shape and the cylinder has an aperture with a generally rectangular cross-sectional shape for receiving the piston.

133. (Original) The apparatus of claim 124 wherein the piston is sealably engaged with the cylinder.

Appl. No. 09/782,892

134. (Original) The apparatus of claim 124, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

135. (Original) The apparatus of claim 124 wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

136. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder; and

a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

137. (Original) The apparatus of claim 136 wherein the planarizing medium includes a polishing pad.

Appl. No. 09/782,892

138. (Original) The apparatus of claim 136 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

139. (Original) The apparatus of claim 136 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

140. (Original) The apparatus of claim 136, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and
a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

141. (Original) The apparatus of claim 136 wherein the sensor includes a force sensor.

142. (Original) The apparatus of claim 136, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

143. (Original) The apparatus of claim 136 wherein the piston has a generally circular cross-sectional shape and the cylinder has an aperture with a generally circular cross-sectional shape for receiving the piston.

144. (Original) The apparatus of claim 136 wherein the piston has a generally rectangular cross-sectional shape and the cylinder has an aperture with a generally rectangular cross-sectional shape for receiving the piston.

Appl. No. 09/782,892

145. (Original) The apparatus of claim 136 wherein the piston is sealably engaged with the cylinder.

146. (Original) The apparatus of claim 136 wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

147. (Original) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder, wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

148. (Original) The apparatus of claim 147 wherein the planarizing medium includes a polishing pad.

Appl. No. 09/782,892

149. (Original) The apparatus of claim 147 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

150. (Original) The apparatus of claim 147 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

151. (Original) The apparatus of claim 147, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force.

152. (Original) The apparatus of claim 147 wherein the sensor includes a force sensor.

153. (Original) The apparatus of claim 147, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

154. (Original) The apparatus of claim 147 wherein the piston has a generally circular cross-sectional shape and the cylinder has an aperture with a generally circular cross-sectional shape for receiving the piston.

155. (Original) The apparatus of claim 147 wherein the piston has a generally rectangular cross-sectional shape and the cylinder has an aperture with a generally rectangular cross-sectional shape for receiving the piston.

Appl. No. 09/782,892

156. (Original) The apparatus of claim 147 wherein the piston is sealably engaged with the cylinder.

157. (Original) The apparatus of claim 147, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

158. (Original) An apparatus for measuring forces during conditioning of a chemical-mechanical planarizing surface, comprising:

a planarizing medium having a planarizing surface for removing material from a microelectronic substrate, the planarizing surface defining a planarizing surface plane;

a conditioning body adjacent to the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium for conditioning the planarizing surface, the conditioning body and the planarizing medium generating a force in the planarizing surface plane when the one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder; and

a sensor operatively coupled to the conditioning body to detect the force; the sensor including a gauge positioned to measure movement of the piston relative to the cylinder.

159. (Original) The apparatus of claim 158 wherein the planarizing medium includes a polishing pad.

160. (Original) The apparatus of claim 158 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

Appl. No. 09/782,892

161. (Original) The apparatus of claim 158 wherein the conditioning body is rotatable relative to the planarizing medium.

162. (Original) The apparatus of claim 158 wherein the conditioning body is translatable relative to the planarizing medium.

163. (Original) The apparatus of claim 158 wherein the planarizing medium is rotatable relative to the conditioning body.

164. (Original) The apparatus of claim 158 wherein the force is a drag force, further comprising:

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force.

165. (Original) The apparatus of claim 158 wherein the sensor includes a force sensor.

166. (Original) The apparatus of claim 158 wherein the piston is sealably engaged with the cylinder.

167. (Original) The apparatus of claim 158, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

168. (Original) The apparatus of claim 158, further comprising a feedback device coupled to the sensor and the conditioning body for changing at least one of the force

Appl. No. 09/782,892

between the conditioning body and the polishing pad and a position of the conditioning body relative to the polishing pad in response to a signal from the sensor.

169. (Original) An apparatus for measuring forces during conditioning of a chemical-mechanical planarizing surface, comprising:

a planarizing medium having a planarizing surface for removing material from a microelectronic substrate, the planarizing surface defining a planarizing surface plane;

a conditioning body adjacent to the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium for conditioning the planarizing surface, the conditioning body and the planarizing medium generating a force in the planarizing surface plane when the one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, wherein the piston is sealably engaged with the cylinder; and

a sensor operatively coupled to the conditioning body to detect the force, the sensor including a gauge positioned to measure movement of the piston relative to the cylinder.

170. (Original) The apparatus of claim 169 wherein the planarizing medium includes a polishing pad.

171. (Original) The apparatus of claim 169 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

172. (Original) The apparatus of claim 169 wherein the conditioning body is rotatable relative to the planarizing medium.

Appl. No. 09/782,892

173. (Original) The apparatus of claim 169 wherein the conditioning body is translatable relative to the planarizing medium.

174. (Original) The apparatus of claim 169 wherein the planarizing medium is rotatable relative to the conditioning body.

175. (Original) The apparatus of claim 169 wherein the force is a drag force, further comprising:

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force.

176. (Original) The apparatus of claim 169 wherein the sensor includes a force sensor.

177. (Original) The apparatus of claim 169, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

178. (Original) The apparatus of claim 169, further comprising a feedback device coupled to the sensor and the conditioning body for changing at least one of the force between the conditioning body and the polishing pad and a position of the conditioning body relative to the polishing pad in response to a signal from the sensor.

Appl. No. 09/782,892

179. (Original) An apparatus for measuring forces during conditioning of a chemical-mechanical planarizing surface, comprising:

a planarizing medium having a planarizing surface for removing material from a microelectronic substrate, the planarizing surface defining a planarizing surface plane;

a conditioning body adjacent to the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium for conditioning the planarizing surface, the conditioning body and the planarizing medium generating a force in the planarizing surface plane when the one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder;

a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder; and

a sensor operatively coupled to the conditioning body to detect the force, the sensor including a gauge positioned to measure movement of the piston relative to the cylinder.

180. (Original) The apparatus of claim 179 wherein the planarizing medium includes a polishing pad.

181. (Original) The apparatus of claim 179 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

182. (Original) The apparatus of claim 179 wherein the conditioning body is rotatable relative to the planarizing medium.

Appl. No. 09/782,892

183. (Original) The apparatus of claim 179 wherein the conditioning body is translatable relative to the planarizing medium.

184. (Original) The apparatus of claim 179 wherein the planarizing medium is rotatable relative to the conditioning body.

185. (Original) The apparatus of claim 179 wherein the force is a drag force, further comprising:

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force.

186. (Original) The apparatus of claim 179 wherein the sensor includes a force sensor.

187. (Original) The apparatus of claim 179 wherein the piston is sealably engaged with the cylinder.

188. (Original) The apparatus of claim 179, further comprising a feedback device coupled to the sensor and the conditioning body for changing at least one of the force between the conditioning body and the polishing pad and a position of the conditioning body relative to the polishing pad in response to a signal from the sensor.

189. (Original) An apparatus for monitoring conditioning of a planarizing medium used for chemical-mechanical planarization of a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the

Appl. No. 09/782,892

planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface, the conditioning body generating a drag force generally parallel to the planarizing surface;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, wherein the piston is sealably engaged with the cylinder;

an actuator coupled to the conditioning body with a support assembly to control at least one of a generally normal force between the conditioning body and the planarizing medium and a position of the conditioning body relative to the planarizing medium;

a sensor coupled to the support assembly to detect the drag force, the sensor including a pressure gauge positioned within the gap to detect a change in pressure in the gap when one of the piston and the cylinder moves relative to the other, the sensor is positioned to detect relative motion between the piston and the cylinder; and

a feedback device coupled to the actuator to control activation of the actuator in response to a signal received from the force sensor.

190. (Original) The apparatus of claim 189 wherein the feedback device includes a microprocessor.

191. (Original) The apparatus of claim 189 wherein the actuator is positioned to move the conditioning body laterally over the planarizing surface.

192. (Original) The apparatus of claim 189 wherein the actuator is positioned to rotate the conditioning body in a generally circular motion over the planarizing surface.

193. (Original) The apparatus of claim 189 wherein the planarizing medium includes a polishing pad.

Appl. No. 09/782,892

194. (Original) The apparatus of claim 189, further comprising:

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force.

195. (Original) The apparatus of claim 189 wherein the sensor includes a force sensor.

196. (Original) The apparatus of claim 189, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

197. (Original) An apparatus for monitoring conditioning of a planarizing medium used for chemical-mechanical planarization of a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface, the conditioning body generating a drag force generally parallel to the planarizing surface;

a piston;

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder,

Appl No. 09/782,892

an actuator coupled to the conditioning body with a support assembly to control at least one of a generally normal force between the conditioning body and the planarizing medium and a position of the conditioning body relative to the planarizing medium;

a sensor coupled to the support assembly to detect the drag force, the sensor being positioned to detect relative motion between the piston and the cylinder;

a feedback device coupled to the actuator to control activation of the actuator in response to a signal received from the force sensor; and

a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

198. (Original) The apparatus of claim 197 wherein the feedback device includes a microprocessor.

199. (Original) The apparatus of claim 197 wherein the actuator is positioned to move the conditioning body laterally over the planarizing surface.

200. (Original) The apparatus of claim 197 wherein the actuator is positioned to rotate the conditioning body in a generally circular motion over the planarizing surface.

201. (Original) The apparatus of claim 197 wherein the planarizing medium includes a polishing pad.

202. (Original) The apparatus of claim 197, further comprising:
a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body; and
a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force.

Appl. No. 09/782,892

203. (Original) The apparatus of claim 197 wherein the sensor includes a force sensor.

204. (Original) The apparatus of claim 197 wherein the piston is sealably engaged with the cylinder and the sensor includes a pressure gauge positioned within the gap to detect a change in pressure in the gap when one of the piston and the cylinder moves relative to the other.

205. (Original) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

moving at least one of the planarizing medium and a conditioning body relative to the other of the planarizing medium and the conditioning body while the conditioning body is engaged with a planarizing surface of the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, the support member including a piston slidably received in a cylinder; and

monitoring the conditioning body to detect a force of the planarizing medium on the conditioning body, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

206. (Original) The method of claim 205 wherein monitoring the conditioning body includes detecting a frictional force on the conditioning body in a plane generally parallel to a plane of the planarizing surface.

207. (Original) The method of claim 205 wherein the support member includes a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein monitoring the conditioning body includes detecting a force between the upwardly extending portion and the laterally extending portion with a force sensor.

Appl. No. 09/782,892

208. (Original) The method of claim 205, further comprising biasing one of the piston and the cylinder toward or away from the other of the piston and the cylinder.

209. (Original) The method of claim 205 wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston, further wherein monitoring the conditioning body includes detecting a pressure within the sealed space.

210. (Original) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

moving at least one of the planarizing medium and a conditioning body relative to the other of the planarizing medium and the conditioning body while the conditioning body is engaged with a planarizing surface of the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, the support member including a piston slidably received in a cylinder;

biasing one of the piston and the cylinder toward or away from the other of the piston and the cylinder; and

monitoring the conditioning body to detect a force of the planarizing medium on the conditioning body, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

211. (Original) The method of claim 210 wherein monitoring the conditioning body includes detecting a frictional force on the conditioning body in a plane generally parallel to a plane of the planarizing surface.

212. (Original) The method of claim 210 wherein the support member includes a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein monitoring the conditioning body includes detecting a force between the upwardly extending portion and the laterally extending portion with a force sensor.

213. (Original) The method of claim 210 wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston, further wherein monitoring the conditioning body includes detecting a pressure within the sealed space.

214. (Original) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

moving at least one of the planarizing medium and a conditioning body relative to the other of the planarizing medium and the conditioning body while the conditioning body is engaged with a planarizing surface of the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, the support member including a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston; and

monitoring the conditioning body to detect a force of the planarizing medium on the conditioning body, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a pressure within the sealed space.

215. (Original) The method of claim 214 wherein monitoring the conditioning body includes detecting a frictional force on the conditioning body in a plane generally parallel to a plane of the planarizing surface.

216. (Original) The method of claim 214 wherein the support member includes a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein monitoring the conditioning body includes detecting a force between the upwardly extending portion and the laterally extending portion with a force sensor.

217. (Original) The method of claim 214 wherein the support member includes a piston slidably received in a cylinder and monitoring the conditioning body includes

Appl. No. 09/782,892

detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

218. (Original) The method of claim 214, further comprising biasing one of the piston and the cylinder toward or away from the other of the piston and the cylinder.

219. (Original) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, the method comprising:

coupling a sensor to a conditioning body, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, and further wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston;

engaging the conditioning body with the planarizing medium and moving at least one of the conditioning body and the planarizing medium relative to the other of the conditioning body and the planarizing medium while the conditioning body engages the planarizing medium; and

monitoring the conditioning body to detect a frictional force between the conditioning body and the planarizing medium, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a pressure within the sealed space.

220. (Original) The method of claim 219 wherein monitoring the conditioning body further includes detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

221. (Original) A method for conditioning a planarizing medium used for planarizing a semiconductor substrate, the method comprising:

engaging a conditioning body with the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative

Appl. No. 09/782,892

to the planarizing medium, the support member including a piston slidably received in a cylinder;

moving at least one of the conditioning body and the planarizing medium relative to the other of the conditioning body and the planarizing medium to remove material from the planarizing medium; and

maintaining an approximately constant frictional force between the conditioning body and the planarizing medium by adjusting a relative velocity between the conditioning body and the planarizing medium, wherein maintaining an approximately constant frictional force includes selecting a target frictional force, detecting a force between the conditioning body and the planarizing medium and adjusting the relative velocity until the force is approximately equal to the target frictional force, wherein detecting the force includes measuring a force transmitted to the support member by the conditioning body by detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

222. (Original) The method of claim 221 wherein the support member includes a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein detecting the force includes detecting a force between the upwardly extending portion and the laterally extending portion with a force sensor.

223. (New) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the

Appl. No. 09/782,892

planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably and sealably engaging the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder.

224. (New) The apparatus of claim 223 wherein the planarizing medium includes a polishing pad.

225. (New) The apparatus of claim 223 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

226. (New) The apparatus of claim 223 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

227. (New) The apparatus of claim 223 wherein the sensor includes a force sensor.

228. (New) The apparatus of claim 223, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the

Appl. No. 09/782,892

actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

229. (New) The apparatus of claim 223, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

230. (New) The apparatus of claim 223 wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

231. (New) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

- a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

- a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

- a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium; [and]

- a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force;

- a piston;

- a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to

Appl. No. 09/782,892

slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder; and
a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

232. (New) The apparatus of claim 231 wherein the planarizing medium includes a polishing pad.

233. (New) The apparatus of claim 231 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

234. (New) The apparatus of claim 231 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

235. (New) The apparatus of claim 231 wherein the sensor includes a force sensor.

236. (New) The apparatus of claim 231, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

237. (New) The apparatus of claim 231 wherein the piston is sealably engaged with the cylinder.

238. (New) The apparatus of claim 231 wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the

Appl. No. 09/782,892

pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

239. (New) An apparatus for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

a conditioning body having a conditioning surface configured to engage a planarizing surface of the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium to condition the planarizing surface;

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

a sensor coupled to the conditioning body to detect a frictional force in a plane of the planarizing surface, the frictional force being imparted to the conditioning body by the planarizing medium when the one of the conditioning body and the planarizing medium is moved relative to the other of the conditioning body and the planarizing medium;

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the frictional force;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the frictional force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the sensor including a gauge positioned to measure movement of the one of the piston and the cylinder relative to the other of the piston and the cylinder, wherein the gauge includes a pointer on one of the piston and the cylinder and a scale on the other of the piston and the cylinder, the pointer being aligned with the scale and movable relative to the scale to indicate relative movement between the piston and the cylinder.

Appl. No. 09/782,892

240. (New) The apparatus of claim 239 wherein the planarizing medium includes a polishing pad.

241. (New) The apparatus of claim 239 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

242. (New) The apparatus of claim 239 wherein the conditioning body includes abrasive elements for abrading the planarizing surface of the planarizing medium.

243. (New) The apparatus of claim 239 wherein the sensor includes a force sensor.

244. (New) The apparatus of claim 239, further comprising an actuator coupled to the conditioning body for controlling at least one of a position of the conditioning body and an approximately normal force between the conditioning body and the planarizing medium, the actuator being coupled to the sensor to receive signals from the sensor and adjust the one of the position and the approximately normal force in response to the signal.

245. (New) The apparatus of claim 239 wherein the piston is sealably engaged with the cylinder.

246. (New) An apparatus for measuring forces during conditioning of a chemical-mechanical planarizing surface, comprising:

a planarizing medium having a planarizing surface for removing material from a microelectronic substrate, the planarizing surface defining a planarizing surface plane;

a conditioning body adjacent to the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium for conditioning the planarizing surface, the conditioning body and the planarizing medium generating a force in the planarizing surface plane when the one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium;

Appl. No. 09/782,892

a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force;

a sensor operatively coupled to the conditioning body to detect the force;

a piston; and

a cylinder having an open end and a closed end, the cylinder slidably and sealably engaging the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the force sensor including a gauge positioned to measure movement of the piston relative to the cylinder.

247. (New) The apparatus of claim 246 wherein the planarizing medium includes a polishing pad.

248. (New) The apparatus of claim 246 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

249. (New) The apparatus of claim 246 wherein the conditioning body is rotatable relative to the planarizing medium.

250. (New) The apparatus of claim 246 wherein the conditioning body is translatable relative to the planarizing medium.

251. (New) The apparatus of claim 246 wherein the planarizing medium is rotatable relative to the conditioning body.

Appl. No. 09/782,892

252. (New) The apparatus of claim 246 wherein the sensor includes a force sensor.

253. (New) The apparatus of claim 246, further comprising a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

254. (New) The apparatus of claim 246, further comprising a feedback device coupled to the sensor and the conditioning body for changing at least one of the force between the conditioning body and the polishing pad and a position of the conditioning body relative to the polishing pad in response to a signal from the sensor.

255. (New) An apparatus for measuring forces during conditioning of a chemical-mechanical planarizing surface, comprising:

- a planarizing medium having a planarizing surface for removing material from a microelectronic substrate, the planarizing surface defining a planarizing surface plane;

- a conditioning body adjacent to the planarizing medium, at least one of the conditioning body and the planarizing medium being movable relative to the other of the conditioning body and the planarizing medium for conditioning the planarizing surface, the conditioning body and the planarizing medium generating a force in the planarizing surface plane when the one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium;

- a first support member having first and second ends and being rotatably coupled toward the first end to the conditioning body, the second end of the first support member extending away from the conditioning body;

- a second support member coupled at a pivotable coupling to the first support member toward the second end of the first support member, the sensor being positioned between the first and second support members, the first support member being pivotable relative to the second support member to transmit a force to the sensor corresponding to the drag force;

- a sensor operatively coupled to the conditioning body to detect the force;

- a piston;

Appl. No. 09/782,892

a cylinder having an open end and a closed end, the cylinder slidably receiving the piston, at least one of the piston and the cylinder being coupled to the conditioning body to slide relative to the other of the piston and the cylinder under the influence of the force on the conditioning body, the piston and the cylinder defining a gap between an end of the piston and the closed end of the cylinder, the force sensor including a gauge positioned to measure movement of the piston relative to the cylinder; and

a biasing member coupled to the cylinder and the piston to bias the piston toward or away from the cylinder.

256. (New) The apparatus of claim 255 wherein the planarizing medium includes a polishing pad.

257. (New) The apparatus of claim 255 wherein the conditioning body has a conditioning surface generally parallel to the planarizing surface.

258. (New) The apparatus of claim 255 wherein the conditioning body is rotatable relative to the planarizing medium.

259. (New) The apparatus of claim 255 wherein the conditioning body is translatable relative to the planarizing medium.

260. (New) The apparatus of claim 255 wherein the planarizing medium is rotatable relative to the conditioning body.

261. (New) The apparatus of claim 255 wherein the sensor includes a force sensor.

262. (New) The apparatus of claim 255 wherein the piston is sealably engaged with the cylinder.

Appl. No. 09/782,892

263. (New) The apparatus of claim 255, further comprising a feedback device coupled to the sensor and the conditioning body for changing at least one of the force between the conditioning body and the polishing pad and a position of the conditioning body relative to the polishing pad in response to a signal from the sensor.

264. (New) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

moving at least one of the planarizing medium and a conditioning body relative to the other of the planarizing medium and the conditioning body while the conditioning body is engaged with a planarizing surface of the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, the support member including a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, further wherein the support member includes a piston slidably received in a cylinder;

monitoring the conditioning body to detect a force of the planarizing medium on the conditioning body, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder; and

biasing one of the piston and the cylinder toward or away from the other of the piston and the cylinder.

265. (New) The method of claim 264 wherein monitoring the conditioning body includes detecting a frictional force on the conditioning body in a plane generally parallel to a plane of the planarizing surface.

266. (New) The method of claim 264 wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston, further wherein monitoring the conditioning body includes detecting a pressure within the sealed space.

Appl. No. 09/782,892

267. (New) The method of claim 264, further comprising removing material from the planarizing medium while at least one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium.

268. (New) The method of claim 264, further comprising adjusting a force applied to the conditioning body approximately normal to the planarizing surface in response to detecting a force of the planarizing medium on the conditioning body.

269. (New) The method of claim 264 wherein moving at least one of the planarizing medium and the conditioning body includes rotating the planarizing medium at a variable rate as the conditioning body moves across the planarizing medium to maintain a relative velocity between the planarizing medium and the conditioning body at an approximately constant value.

270. (New) A method for monitoring conditioning of a planarizing medium used for planarizing a microelectronic substrate, comprising:

moving at least one of the planarizing medium and a conditioning body relative to the other of the planarizing medium and the conditioning body while the conditioning body is engaged with a planarizing surface of the planarizing medium, wherein the conditioning body is coupled to a support member for supporting the conditioning body relative to the planarizing medium, the support member including a generally upwardly extending portion coupled to the conditioning body and a generally laterally extending portion pivotably coupled to the upwardly extending portion, wherein the support member includes a piston slidably and sealably received in a cylinder to form a sealed space between an end of the cylinder and an end of the piston; and

monitoring the conditioning body to detect a force of the planarizing medium on the conditioning body, wherein monitoring the conditioning body includes measuring a force transmitted to the support member by the conditioning body by detecting a pressure within the sealed space.

Appl. No. 09/782,892

271. (New) The method of claim 270 wherein monitoring the conditioning body includes detecting a frictional force on the conditioning body in a plane generally parallel to a plane of the planarizing surface.

272. (New) The method of claim 270 wherein the support member includes a piston slidably received in a cylinder and monitoring the conditioning body includes detecting a movement of one of the piston and the cylinder relative to the other of the piston and the cylinder.

273. (New) The method of claim 272, further comprising biasing one of the piston and the cylinder toward or away from the other of the piston and the cylinder.

274. (New) The method of claim 270, further comprising removing material from the planarizing medium while at least one of the conditioning body and the planarizing medium moves relative to the other of the conditioning body and the planarizing medium.

275. (New) The method of claim 270, further comprising adjusting a force applied to the conditioning body approximately normal to the planarizing surface in response to detecting a force of the planarizing medium on the conditioning body.

276. (New) The method of claim 270 wherein moving at least one of the planarizing medium and the conditioning body includes rotating the planarizing medium at a variable rate as the conditioning body moves across the planarizing medium to maintain a relative velocity between the planarizing medium and the conditioning body at an approximately constant value.